9-06 STRUCTURAL STEEL AND RELATED MATERIALS

9-06.1 Structural Carbon Steel

Structural carbon steel shall conform to AASHTO M 270, Grade 36, except as otherwise noted.

9-06.2 Structural Low Alloy Steel

Structural low alloy steel shall conform to AASHTO M 270, Grade 50 or 50W as specified in the Plans or Special Provisions, except as otherwise noted.

9-06.3 Structural High Strength Steel

Structural high strength steel shall be high yield strength, quenched and tempered structural steel conforming to AASHTO M 270, Grades 70W, 100, or 100W as specified in the Plans or Special Provisions, except as otherwise noted.

9-06.4 Vacant

9-06.5 Bolts

9-06.5(1) Unfinished Bolts

Unfinished bolts (ordinary machine bolts) shall conform to the Specification requirements of ASTM A 307 Grade A or B. Nuts shall comply with ASTM A 563 Grade A requirements. Washers, unless otherwise specified, shall meet ASTM F 844 Specifications.

The Contractor shall submit a Manufacturer's Certificate of Compliance for the bolts, nuts, and washers prior to installing any of them.

9-06.5(2) Vacant

9-06.5(3) High Strength Bolts

High strength bolts for structural steel joints shall conform to the requirements of AASHTO M 164 or M 253 Type 1, 2, or 3.

Bolts conforming to AASHTO M 164, having an ultimate tensile strength above 145 ksi and are galvanized in accordance with AASHTO M 232, shall be tested for embrittlement. Embrittlement testing shall be conducted after galvanization in accordance with ASTM F 606, Section 7. The Manufacturer's Certificate of Compliance for the lot provided shall show the ultimate tensile strength test results. Bolts conforming to AASHTO M 253 shall not be galvanized. AASHTO M 253 Type 1 and 2 bolts shall be painted with two coats of zinc rich paint, formula A-9-73, consisting of a minimum dry film thickness of 2 mils per coat.

Unpainted and nongalvanized bolts shall conform to AASHTO M 164 and M 253 Type 3.

Nuts for high strength bolts shall meet the following requirements:

AASHTO M 164 Bolts

Black or galvanized Type 1	AASHTO M 291 Grade C, C3, DH, and DH3 AASHTO M 292 Grade 2H
Black weathering Type 3	AASHTO M 291 Grade C3 and DH3
Galvanized Type 1	AASHTO M291 Grade DH AASHTO M 292 Grade 2H

AASHTO M 253 Bolts	
Black Type 1 and 2	AASHTO M 291 Grade DH, DH3 AASHTO M 292 Grade 2H
Black weathering Type 3	AASHTO M 291 Grade DH3

Nuts that are to be galvanized shall be tapped oversized the minimum required for proper assembly. The amount of overtap shall be such that the nut will assemble freely on the bolt in the coated condition and shall meet the mechanical requirements of AASHTO M 291 and the rotational capacity test specified in AASHTO M 164.

Galvanized nuts shall be lubricated in accordance with AASHTO M 291 including supplementary requirement S2. Documentation shall include the name, method of application, and dilution of the lubricant applied to the nuts.

Washers for AASHTO M 164 Type 1 and 3 bolts; and AASHTO M 253 Type 1, 2, and 3 bolts shall meet the requirements of AASHTO M 293. The surface condition and weathering characteristics of the washers shall be the same as for the bolts being specified.

Direct Tension Indicators shall conform to the requirements of ASTM F 959 and may be used with either AASHTO M 164 or M 253 bolts. Direct tension indicators shall be galvanized by mechanical deposition in accordance with AASHTO M 298 class 55. Hot dip galvanizing will not be allowed.

All bolts, nuts, and direct tension indicators shall be marked and identified as required in the pertinent Specifications.

Lock-pin and collar fasteners which meet the materials, manufacturing, and chemical composition requirements of AASHTO M 164 or AASHTO M 253, and which meet the mechanical property requirements of the same Specification in full size tests, and which have a body diameter and bearing areas under lock-pin head and collar not less than those provided by a bolt and nut of the same nominal size may be used. The Contractor shall submit a detailed installation procedure to the Engineer for approval. Approval to use a lock-pin and collar fasteners will be given by the Engineer prior to use on these types of fasteners.

The Contractor shall provide Manufacturer's Certificate of Compliance for all bolts, nuts, washers, and load indicators. The Manufacturer's Certificate of Compliance shall include certified mill test reports and test reports performed on the finished bolt confirming that all of the materials provided meet the requirements of the applicable AASHTO or ASTM Specification. The documentation shall also include the name and address of the test laboratory, the date of testing, the lot identification of the bolts and nuts, and coating thickness for galvanized bolts and nuts. Shipping containers (not lids) shall be marked with the lot identification of the item contained therein.

Bolts shall be sampled prior to incorporating into a structure. For the purposes of selecting samples, a lot of bolts shall be the quantity of bolts of the same nominal diameter and same nominal length in a consignment shipped to the project site. The minimum number of samples from each lot shall be as follows:

Lot Size	Sample Size[1,2]
0 to 50	*
51 to 150	4
151 to 1,200	6
1,201 to 10,000	10
10,001 to 35,000	16
35,001 and over	24

*Manufacturer's Certificate of Compliance — samples not required.

[1]If bolts are galvanized, increase the sample size by 1.5 times the table value for the number of bolts being sampled.

[2]Nuts, washers, and load indicator devices shall be sampled at the same frequency as the bolts.

All testing of bolts, nuts, washers, and load indicating devices shall be performed on specimens as they are to be installed.

All samples shall include a Manufacturer's Certificate of Compliance for each lot of bolts provided as defined in Section 1-06.3.

9-06.5(4) Anchor Bolts

Anchor bolts shall meet the requirements of ASTM F 1554 and, unless otherwise specified, shall be Grade 105 and shall conform to Supplemental Requirements S2, S3, and S4.

Nuts for ASTM F 1554 Grade 105 black anchor bolts shall conform to AASHTO M 291, Grade D or DH. Nuts for ASTM F 1554 Grade 105 galvanized bolts shall conform to AASHTO M 291, Grade DH and shall conform to the lubrication requirements in Section 9-06.5(3). Nuts for ASTM F 1554 Grade 36 or 55 black or galvanized anchor bolts shall conform to AASHTO M 291, Grade A. Washers shall conform to ASTM F 436.

The bolts shall be tested by the manufacturer in accordance with the requirements of the pertinent Specification and as specified in these Specifications. Anchor bolts, nuts, and washers shall be inspected prior to shipping to the project site. The Contractor shall submit to the Engineer for approval a Manufacturer's Certificate of Compliance for the anchor bolts, nuts, and washers, as defined in Section 1-06.3. If the Engineer deems it appropriate, the Contractor shall provide a sample of the anchor bolt, nut, and washer for testing.

All bolts, nuts, and washers shall be marked and identified as required in the pertinent Specification.

9-06.6 Vacant

9-06.7 Vacant

9-06.8 Steel Castings

Steel castings shall conform to the requirements of AASHTO M 103, Mild to Medium Strength Carbon Steel Castings for General Application, grade 70-36, unless otherwise designated in the Plans or in the Special Provisions.

9-06.9 Gray Iron Castings

Gray iron castings shall conform to the requirements of AASHTO M 306. The class of castings to be furnished shall be that designated in the Plans or in the Special Provisions.

9-06.10 Malleable Iron Castings

Malleable iron castings shall conform to the requirements of ASTM A 47.

9-06.11 Steel Forgings and Steel Shafting

Steel forgings shall conform to the requirements of AASHTO M 102. The classes of forgings to be furnished shall be those specified in the Plans or in the Special Provisions.

Steel shafting shall conform to the requirements of AASHTO M 169, Grade Designation 1016 to 1030 inclusive, unless otherwise specified.

9-06.12 Bronze Castings

Bronze castings shall conform to the requirements of AASHTO M 107, Bronze Castings for Bridges and Turntables.

9-06.13 Copper Seals

Copper sheets for seals shall conform to the requirements of AASHTO M 138. They shall be UNS C12500, light cold rolled, and furnished in flat sheets each not less than 0.018-inch in thickness.

All splices or joints shall be carefully brazed or soldered to produce a continuous watertight seal for the full length of each unit.

9-06.14 Ductile Iron Castings

Ductile iron castings shall conform to the requirements of ASTM A 536, Grade 80-55-06, unless otherwise specified in the Plans or in the Special Provisions.

9-06.15 Welded Shear Connectors

Welded shear studs shall be made from cold drawn bar stock conforming to the requirements of AASHTO M 169. Grades 1010 through 1020, inclusive, either semi-killed or killed deoxidation.

The material shall conform to the following mechanical properties:

Tensile Strength	60,000 psi min.
Yield Strength	50,000 psi min.
Elongation	20% min.
Reduction of Area	50% min.

Mechanical properties shall be determined in accordance with AASHTO Methods and Definitions T 244.

At the manufacturer's option, mechanical properties of the studs shall be determined by testing either the steel after cold finishing, or the full diameter finished studs.

9-06.16 Roadside Sign Structures

All bolts, nuts, washers, cap screws, and coupling bolts shall conform to AASHTO M 164 and Section 9-06.5(3). All connecting hardware shall be galvanized after fabrication in accordance with AASHTO M 232.

Posts for single post sign structures shall meet the requirements of ASTM A 500 Grade B or ASTM A 53 Grade B, Type E or S.

Posts for multiple post sign structures shall conform to either ASTM A 36 or ASTM A 992. Posts conforming to either ASTM A 588 or ASTM A 572 Grade 50 may be used as an acceptable alternate to the ASTM A 36 and ASTM A 992 posts. All steel not otherwise specified shall conform to either ASTM A 36 or ASTM A 992.

Triangular base stiffeners for one-directional multi-post sign posts shall conform to either ASTM A 588 or ASTM A 572, Grade 50.

All steel, including posts, base plates, and base stiffeners, shall be galvanized after fabrication in accordance with AASHTO M111.

Base connectors for multiple directional steel breakaway posts shall conform to the following:

Brackets	Aluminum Alloy 6061 T-6
Bosses for Type 2B Brackets	ASTM A 582
Anchor Ferrules	Type 304 stainless steel for threaded portion. AISI 1038 steel rod and AISI 1008 coil for cage portion.

Anchor couplings for multiple directional steel breakaway posts shall conform to AMS 6378D with a tensile breaking strength range as follows:

Type 2A	17,000 to 21,000 lb.
Type 2B	47,000 to 57,000 lb.

For multi-directional breakaway base connectors, shims shall conform to ASTM A 653, SS Grade 33, Coating Designation G 165. For one-directional breakaway base connectors, single post or multi-post, shims shall be fabricated conforming to ASTM B 36.

9-06.17 Vacant

9-06.18 Metal Bridge Railing

Metal bridge railing shall conform to the type and material Specifications set forth in the Plans and Special Provisions. Steel used for metal railings, when galvanized after fabrication in accordance with AASHTO M 111, shall have a controlled silicon content of either 0.00 to 0.04 percent or 0.15 to 0.25 percent. Mill test certificates verifying the silicon content of the steel shall be submitted to both the galvanizer and the Engineer prior to beginning galvanizing operations.

Section 8, part (b) of the Aluminum Association Standard Specifications for Aluminum Railing Posts Alloy A 344-T4 is hereby revised to provide that no X-ray inspection will be required after a foundry technique has been established for each mold which will ensure production of castings which are free from harmful defects. Inspection for approval of castings will be made by the Engineer after the finished castings have been anodized as noted in the Plans.

Welding of aluminum shall be in accordance with Section 9-28.14(3).

9-06.19 Vacant

9-06.20 Vacant

9-06.21 Vacant

9-06.22 Bolts, Washers, and Other Hardware

Ordinary machine bolts and flat head bolts shall be made from commercial bolt stock meeting the Specifications of ASTM A 307, and shall be grade A. Drift bolts and dowels may be either wrought iron or medium steel. Washers may be cast iron or malleable iron or may be cut from medium steel or wrought iron plate.

All bolts and other hardware which are to be galvanized and which require bending or shaping shall be hot forged to the required shape before galvanizing. Cold bending of such material will not be permitted because of the tendency toward embrittlement during the galvanizing process. Galvanizing shall be in accordance with AASHTO M 232.

Split rings for log cribbing of 4-inches inside diameter shall be manufactured from hot rolled, low carbon steel conforming to ASTM A 711 AISI, Grade 1015. Each ring shall form a true circle with the principle axis of the cross section of the ring metal parallel to the geometric axis of the ring. The thickness of the metal section shall be 0.195-inch plus or minus 0.010-inch and the section shall be beveled from the central portion toward the edges to a thickness of 0.145-inch plus or minus 0.010-inch. It shall be cut through in one place in its circumference to form a tongue and slot. Split ring connectors shall be galvanized in accordance with AASHTO M 232.

Spike-grid timber connectors shall be manufactured according to ASTM A 47 for malleable iron castings. They shall consist of 4 rows of opposing spikes forming a 4⅛-inch square grid with 16 teeth which are held in place by fillets which are diamond shaped in cross section.

Nails shall be round wire of standard form. Spikes shall be wire spikes or boat spikes, as specified in the Plans. Bolts, dowels, washers, and other hardware, including nails, shall be black or galvanized as specified in the Plans, but if not so specified shall be galvanized when used in treated timber structures.